Periodic comb reflection frequency selective surface for interference reduction

C. J. Davenport and J.M. Rigelsford

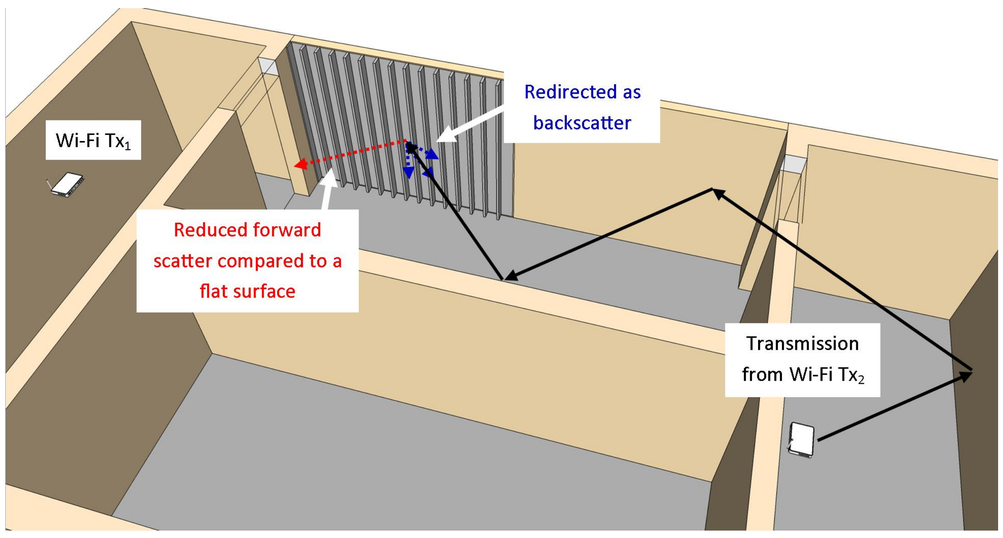
Department of Electronic & Electrical Engineering, The University of Sheffield, Sheffield, S1 3JD, UK

Abstract

This work presents a periodic comb reflection frequency selective surface (CR-FSS), which is designed to offer a reduction in forward scatter over a broadband frequency response. The passive structure is controlled by various factors such as the period, height, and thickness of the surface.

Why? Develop an understanding of passive periodic structures, in order to aid the design of further passive and active frequency selective surfaces in future work.

ENGINEERING APPLICATION

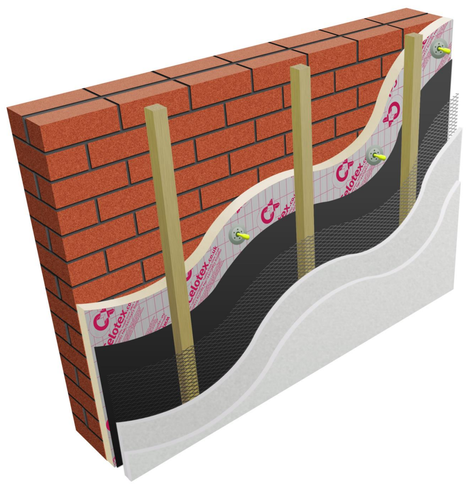


Interference

Propagation of wireless transmissions down corridors can mean Wi-Fi nodes are affected by interference from neighbouring transmitters, reducing their capacity. Comb reflection frequency selective surfaces (CR-FSS) can be installed in corridors to decrease the forward scatter of propagating signals and reduce the level of interference.

BUILDING DESIGN

Development of corridor surfaces is of interest, as it is often the main route of propagation between rooms, especially when the enclosing walls are constructed with metallised insulation. For maximum cost-efficiency, the CR-FSS would be incorporated into the corridor structure during the building construction.

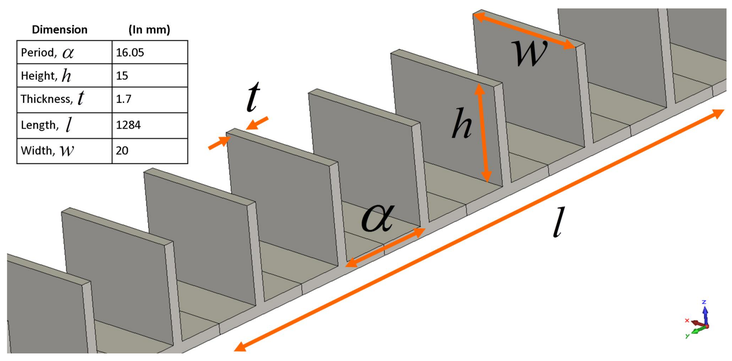


Design

By optimising the period of the comb structures we can control the direction of the reflected wave over a predefined range of frequencies.

CST MODEL

Dimension	(In mm)
Period, α	16.05
Height, h	15
Thickness, t	1.7
Length, l	1284
Width, w	20



Frequency dependence is based on period of the surface. The angle and frequency of backscatter is dependant on the following relationship:

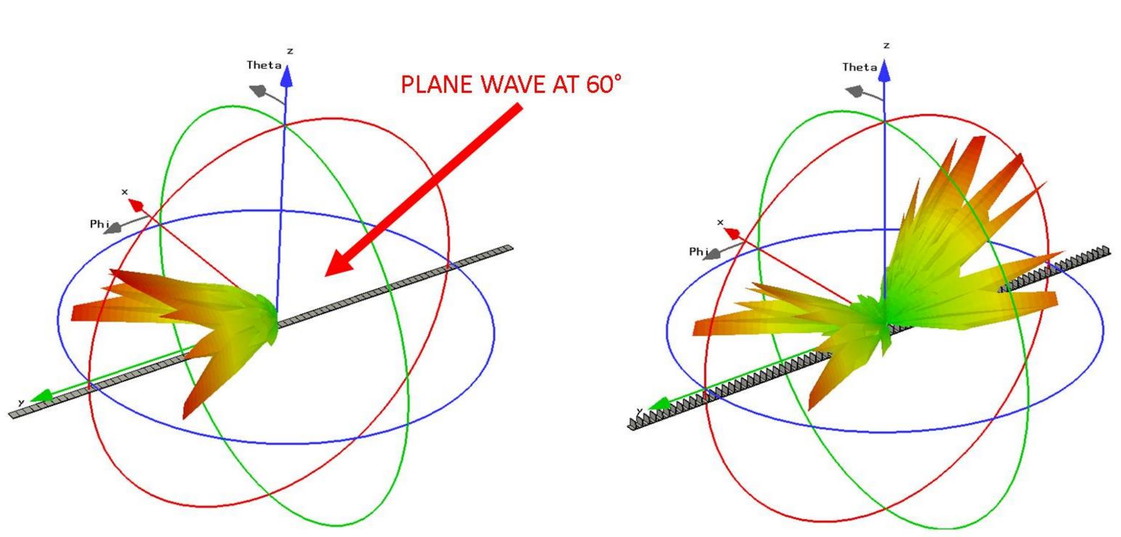
$$\theta_i = \sin^{-1}\left(\frac{\lambda}{2\alpha}\right)$$

Where θ_i is the angle of incidence, λ is the wavelength, and α is the period of the surface. It is thus evident that the angle of arrival can have an affect on the frequency range of the surface.

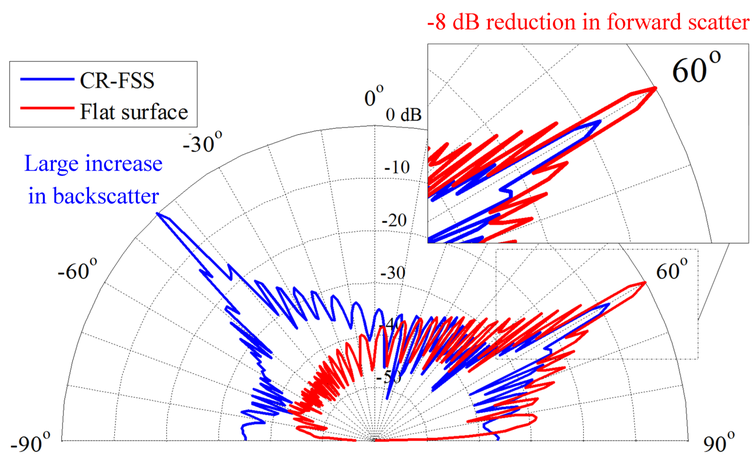
Results

To calculate the relative reduction of forward scatter when using the CR-FSS, a flat PEC surface was also simulated. This surface is representative of a perfect reflector, so the majority of reflections should be forward.

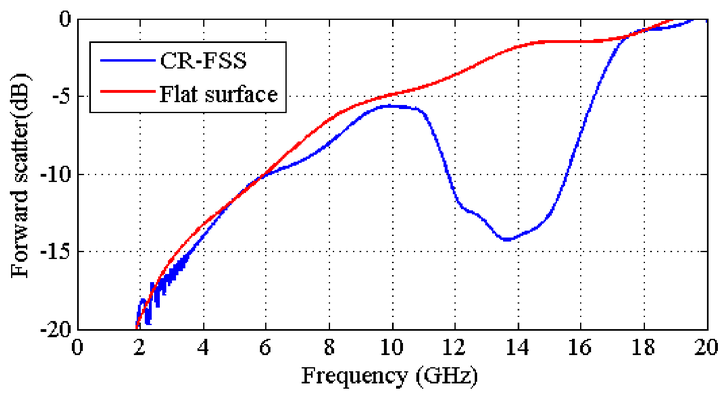
3-D SCATTERING CROSS SECTION



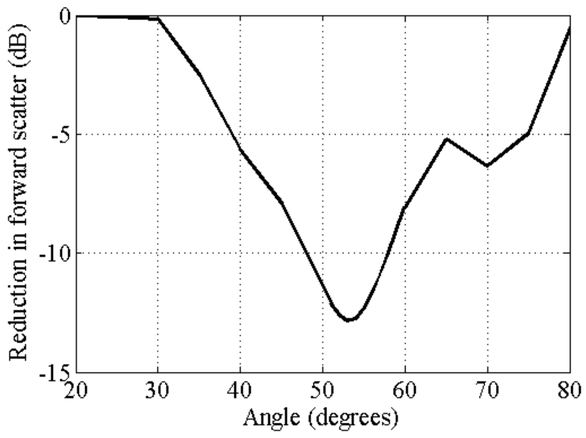
RADAR CROSS SECTION



FORWARD SCATTER FREQUENCY RANGE



ANGULAR DEPENDANCE



The reduction of the forward scatter is the most important indicator on deciding if the surface is operating effectively in this scenario. The radar cross section plot can be used to understand how the scattering spectrum changes when parameters such as the frequency and angle of incidence vary.

The frequency range of the surface for an angle of incidence of 60˚ is 10.8 GHz to 17 GHz. There is a large reduction in forward scatter in this frequency region.

The angle of incidence of the plane wave is not controllable in an in-situ environment, and results show the effectiveness of the surface over the entire range. It can be shown that the forward scatter is reduced between $30° \leq \theta_i \leq 80°$, with a peak reduction at 53˚ of 12.8 dB.

Conclusions

A comb reflection frequency selective surface (CR-FSS) has been designed to reduce interference caused by propagation between adjacent co-channel Wi-Fi access points down corridors. Simulation results of the CR-FSS from CST MWS show the frequency and angular characteristics when reducing the forward scatter of an incoming vertically polarized plane wave.

Industrial sponsor

British Gas

christopher.davenport@sheffield.ac.uk, j.m.rigelsford@sheffield.ac.uk

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Research Councils UK Energy For a Low Carbon Future

E-Futures